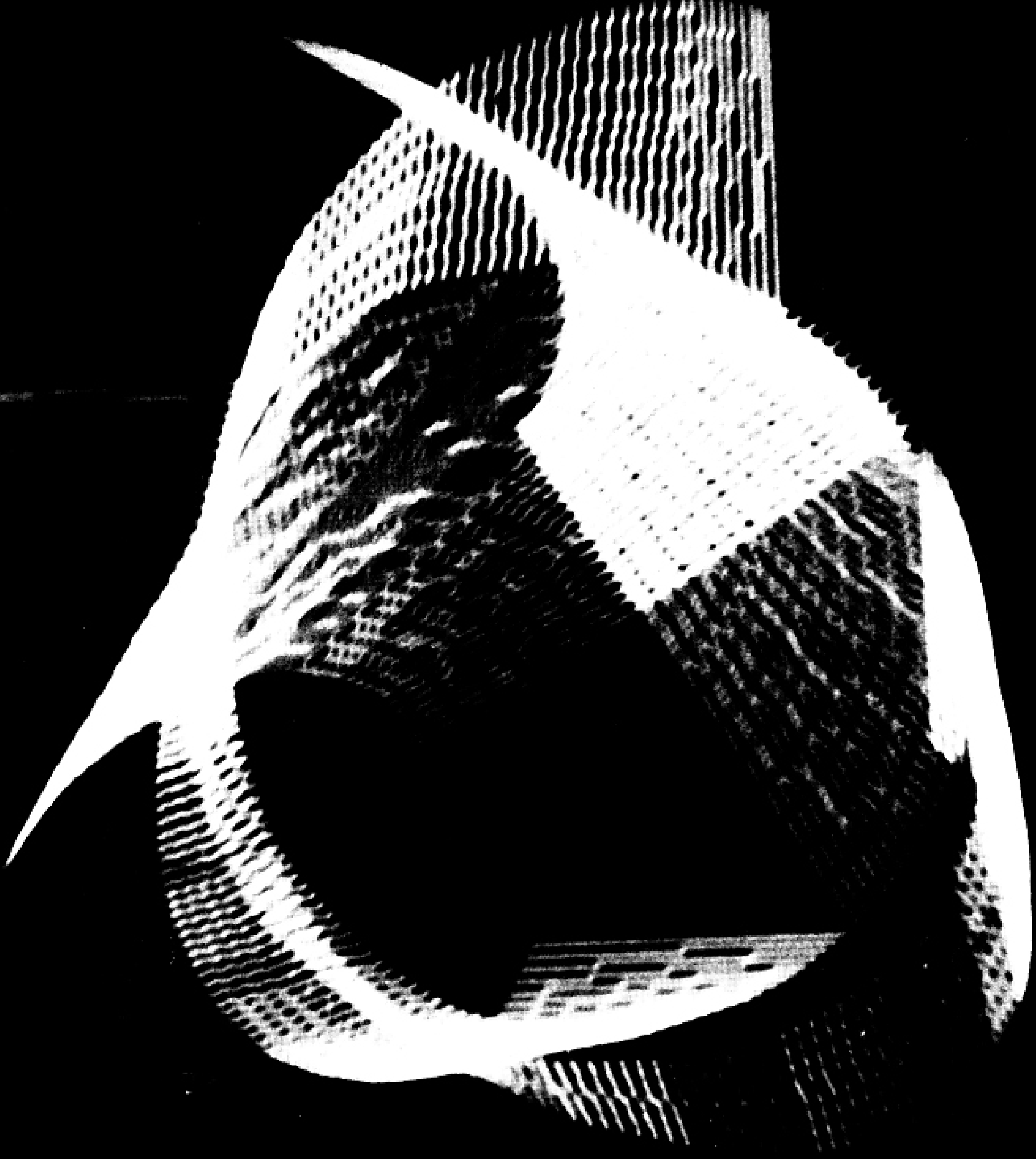
COMPUTER GRAPHICS AND ART



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COMPUTER GRAPHICS AND ART

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THE MAGAZINE OF INTERDISCIPLINARY COMPUTER GRAPHICS FOR PROFESSIONAL GRAPHICS PEOPLE AND COMPUTER ARTISTS

1 - FRONT COVER - "Flowers" by Professors Dick Land and Dan Cohen, Engineering Sciences, Laboratory, Harvard University, Cambridge, Mass.

3 - EDITORIAL - MAKE DO WITH WHAT YOU HAVE by Grace C. Hertlein

4 - INTERACTIVE, DYNAMIC, COMPUTER ART by Dick Land and Dan Cohen, Harvard University, Cambridge, Mass.
The "Flower" system generates unpredictable dynamic patterns that are dependent upon operator interaction. Dynamic, moving forms are displayed on a CRT.

8 - ART OF THE SPACE ERA by Carolyn Wood, Curator of the Huntsville Museum of art - Excerpts from Catalog I.

9 - ADVERTISEMENT, ELSEVIER NORTH-HOLLAND, INC.
UNTITLED TRANSFORMATION by Sture Johannesson and Sten Kallin, Malmo Sweden - Illustration only.

10 - BEAUTY AND IMPRESSION by Mutsuko K. Sasaki, Tokyo, Japan - Illustration and comments, ASE (Art of the Space Era) Show.

11 - ALGORITHMIC ART OF THE SPACE ERA by Peter Milojevic, Toronto, Canada - Graphic and comments, ASE Show.

12 - SNE COMP ART: A SOFTWARE PACKAGE FOR CREATIVE PROBLEMS BY GRAPHIC DATA PROCESSING by Hans Korneder, Munich, Germany
A "user-oriented" system, SNE COMP ART, from the University of Munich is presented in depth. The basic elements, basic structure, and arrangements of forms are discussed and illustrated well.

16 - HIEROGLYPHS by Aaron Marcus, Jerusalem, Israel - Illustrations and comments are given by the artist on his glyph-like works.

18 - THE TECHNOLOGY OF EACH ERA by Lillian Schwartz and C. B. Rubenstein, Watchung, New Jersey - Illustration and philosophy by Lillian Schwartz - ASE Exhibition.

19 - OSCILLONS: ELECTRONIC ABSTRACTIONS by Ben Laposky, Cherokee, Iowa - Illustration and comments, ASE Show.

20 - EXPERIMENTAL ESTHETICS WITH COMPUTER GRAPHICS -- ANALYSES OF VIEWERS' IMPRESSIONS OF COMPUTER GRAPHICS by Professor Reiner Schneeberger, University of Munich
An experiment, using 10 related graphics, is tested on art teachers. Analyses of results are given in detail, with statistical manipulations.

28 - UNIVERSITY OF IOWA - May 1-2, 1978 - Announcement of a special memorial computer conference.

29 - ADVERTISEMENT, COMPUTERS AND PEOPLE

30 - OUTER SPACE AND TECHNOLOGICAL PROGRESS by Roger Coqart, Brussels, Belgium - ASE illustration and comments.

31 - UNIMAGINABLE IMAGES by Vera Molnar, Paris, France - ASE graphic and philosophy by the artist.

32 - VARIED ATTITUDES HELD TOWARD COMPUTER ART by Professors Paul Shao and Ken Dunker, Iowa State University - Graphic and comments, from the ASE Exhibition.

33 - OUTER SPACE -- INNER SPACE by Duane Palyka, New York Institute of Technology, Old Westbury, New York - Graphics and comments, from ASE Show.

34 - COMPUTER ART - THE EMBRYONIC STAGES OF A NEW ART by by Edvard Zajec and Matjaz Hmeljak, Trieste, Italy - ASE illustrations and philosophy.

35 - CG&A AD - Special rate announcement for graphics people.

36 - FLOWERS by Dick Land and Dan Cohen, Harvard University.

This is an excerpt of the full publication by Reiner Schneeberger

EDITORIAL

MAKE DO WITH WHAT YOU HAVE

Recently several incidents have recalled the idea of "making do with what you have." Too often there is the mistaken idea that one must have very expensive hardware and software to achieve innovative graphics. Here are some examples:

THE NEEDS OF SMALL INSTITUTIONS

I was preparing an invitational paper for a computer conference of small colleges. The conference leader asked me to suggest ideas that these small institutions could afford to achieve graphics. The idea came readily to mind: "Make do with what you have. Don't wish for the moon."

THE NEED FOR AWARENESS BY STUDENTS

I was lecturing and demonstrating art graphics to a group of students in an advanced software class. They were bemoaning the lack of complex animation equipment. In discussing their current research, I found that many of them were re-inventing the wheel, repeating experiments that were already available on our campus. They had failed to assess what was available. When they were told that such routines were already in existence, they replied, "Oh, I was interested in the theory. It doesn't matter if I repeat what someone else has already done."

However, if more students were aware of what has been done, they could use their fine talents to take previous research and add improvements, to render these systems available for new users, etc.

THE NEED FOR INTEGRATION OF FACILITIES, SOFTWARE

It is becoming increasingly common for institutions to hire a special coordinator for instructional computing. Some common needs are: teaching teachers how to compute; coordinating programs that are available; securing needed software; planning new hardware, etc.

I talked with such a coordinator a few weeks ago. He enthusiastically expounded on grand plans for expensive new hardware. I listened for some time, and then said:

- *Do you know what we already have available?*
- *Have we ascertained that existing materials and facilities are being fully used?*
- *Are we making use of knowledgeable people on our own campus?*
- *Have we ascertained what programs we can get free of charge from our own system?*
- *Have we investigated to find out what we can obtain from our regional computer consortium?*
- *Have we researched what is available from national organizations, as EDUCOM and CONDUIT?*
- *Have we planned specific workshops for special groups of people?*

RE-INVENTION OF THE WHEEL

Repeatedly at national and international conferences we see research that is identical with previous discoveries. Professors are not the only persons who fail to review the literature. Intermediate and advanced students are too often guilty of the same practice.

There is something more important here than ignorance, ego, or immaturity. It is the lack of objective study and thinking about the work of others. Too often we accept authorities as minor gods, and do not question openly what has been accomplished -- and do not appreciate sufficiently what has been done. This is intellectual immaturity.

KNOW WHAT IS AVAILABLE

The valuable resources of many institutions are wasted because systems are locked up (for the privileged use of specific users). Making full use of facilities is mandatory for any institution.

Information on facilities and available software is not openly advertised for potential users. Information is often poorly organized for varied types of users.

GOING BEYOND WHAT YOU HAVE

After making sure that what is available is well used, there is an innovative place, where one can get hardware and software to do things beyond their original intent or scope. For example, many institutions do "pseudo" animation on storage tube CRTs. Many small schools only have printer graphic capabilities. Many groups do not have plotters and utilize hard copy units from CRTs until they can afford to buy other hardware.

After innovatively using what is available, it is sensible to have expansion plans, wisely knowing what is affordable, and what works, particularly in a student environment, where equipment must be "student proof". Often it is necessary to learn to write good feasibility studies, in order to get the new hardware and software.

Computer graphics is like the art of great cooking. A superb cook can make a marvelous meal from almost nothing. A mediocre cook requires only expensive, rare ingredients.

It will be some time before microfilm and frame buffer systems are affordable by many institutions. In the meantime, we can achieve innovative works with what we have, what we can afford, and what we can procure -- in the near future.

Editor, CG&A

EXPERIMENTAL ESTHETICS WITH COMPUTER GRAPHICS-- ANALYSES OF VIEWERS' IMPRESSIONS OF COMPUTER GRAPHICS

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This article is closely related to the material on SNE COMP ART by Hans Korneder, on pages 12 through 15.

BACKGROUND INFORMATION

During the summer of 1976, the author gave a course in programming computer graphics at the pedagogic department of the University of Munich. The course was especially planned for art teachers. A brief article in the November, 1976 issue of this magazine describes the course itself. /1/ This new article discusses the first experiments at the University of Munich with statistical testing of impressions of viewers' impressions of computer graphics. In this paper, the statistical and simultaneous theoretic bases are given, along with the results of this first experiment with art teachers as test persons. The test itself is described, along with the results of the test. The graphics used in the test are shown throughout the article, as Figures 1 through 10.

AIMS AND OBJECTIVES OF THE BEGINNING TESTS

In a series of brief tests, computer graphics were to be evaluated by various criteria. The results were intended to afford answers to the following questions:

1. How are computer graphics evaluated by various criteria?

2. Up to what point do the opinions of the viewers coincide; i.e., how reliable (or concordant) are their statements of preferences?

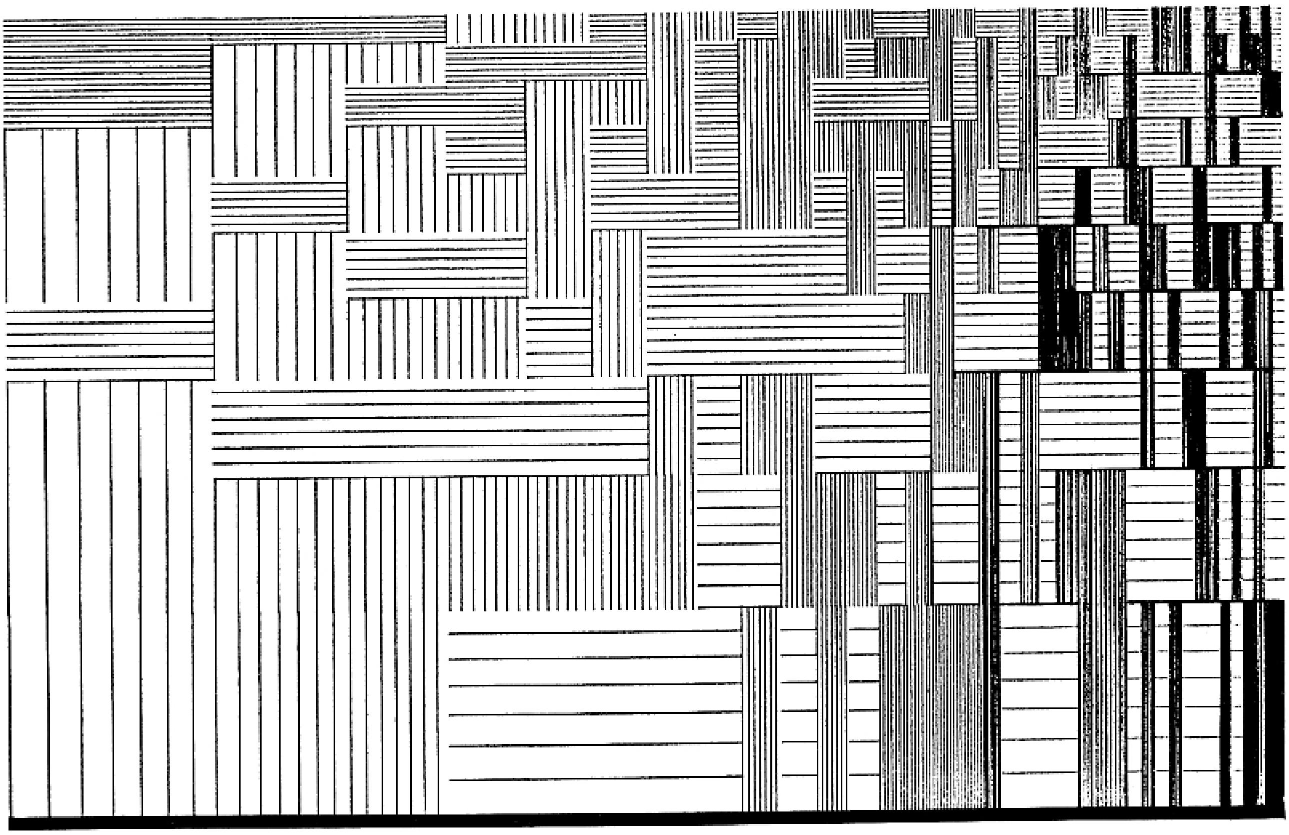
3. How can the expression "liking" (beauty, general impressions) be circumscribed by the various criteria?

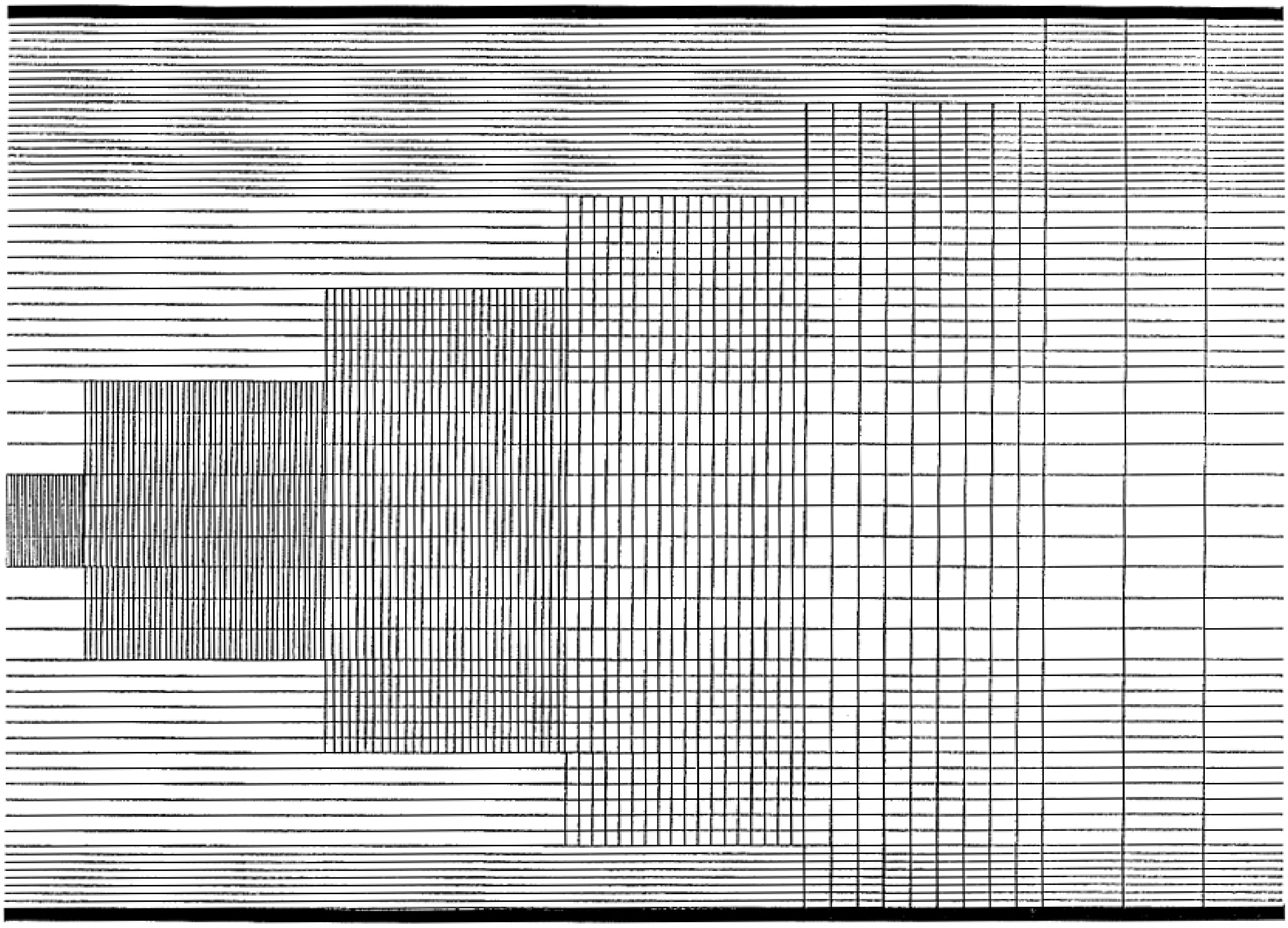
4. What are the differences between the opinions of "artists" (art teachers) and "non-artists" (industrial managers)?

In addition to seeking to measure preferences, as a long-range objective, the author wanted to set up rules for the optimal designing of computer graphics for different ranges of application. The impressions of viewers gives some clues as to this optimal designing of graphics.

The analysis of the differences between the opinions of "artists" and "non-artists" is not yet completed. However, sufficient information is available at this time to note some differences, and to form some conclusions. The finished work will be published at a later date.

BELOW: Picture number 1, one of a series of ten graphics used in the preference experiments. All works are rectilinear, yet each graphic is unique in spatial relationships, variety of black and white areas, etc.





ABOVE: Picture number 2, a precise, orderly rectilinear composition.

DESCRIPTION OF THE TEST

The test persons (art teachers) were given the ten computer graphics included in this text. (See Figures 1 through 10, shown in numerical order.) The graphics served as test materials, together with questions Q1 through Q7. The viewer was asked to arrange the ten graphics in preference order, highest to lowest, in the artist's opinion. The results of this selection is a succession of ten classes for the ten pictures. Here the succession of classes starts with zero instead of one as the highest value. Nine receives the lowest preference value.

CLASSES	0	1	2	3	4	5	6	7	8	9
PICTURES	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

If, for example, a person (X) has set up the following succession:

8 3 4 10 7 2 1 5 9 6

this means, that person X has set the "highest" value on picture 8, followed by pictures 3 and 4. In this brief example, for picture 6, the viewer has assigned the "lowest" value.

It is necessary to note that successions of classes do not give a metric scale; i.e., they only show that picture 8 is considered "better" than picture 3, which in turn, is "better" than picture 4. The preferences given do not show how much the pictures are considered to be better.

For this initial test 18 art teachers participated in the research. The 10 computer graphics to be evaluated in the test were produced by the routine, SNEKAO, of the graphic system SNE COMP ART 76. The works are quite similar to each other; i.e., they are all of one "class" or family. Thus a relatively homogeneous test material is provided.

OTHER EXAMPLES -- AND POSSIBLE TESTS

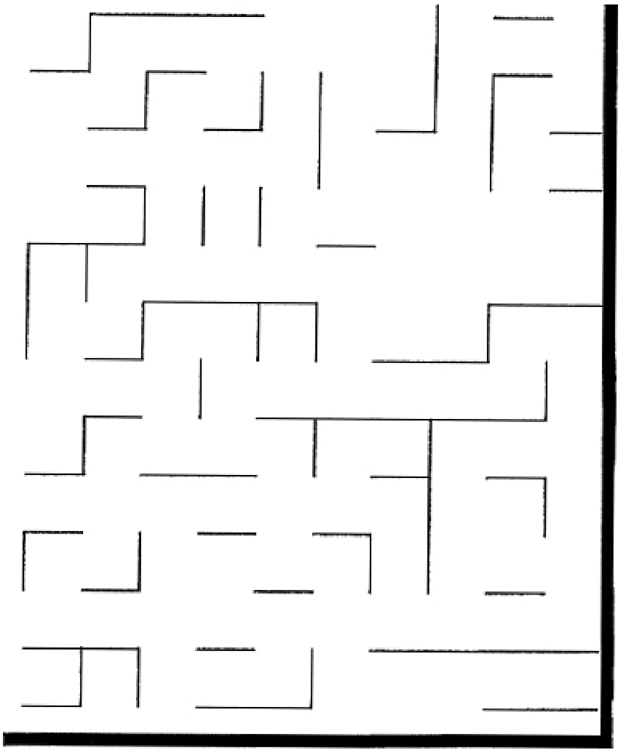
The article, "SNE COMP ART - A Software Package for Creative Problems by Graphic Data Processing" by Hans Korneder, illustrates further types of graphics available from the system.

The questions Q1 through Q6 referred only to the first three classes, and the latter three ones are not very evident. Working with all the classes would have required very intense concentration of the test persons. By answering the question Q7 (general impression), the test persons had to evaluate all the 10 classes.

THE TEST QUESTIONS

Question Q1 - Evaluate the balance (or share) of black and white in the graphic. Arrange the pictures according to this criterion. Write the number of the preferred pictures in the squares -- only first and latter three classes.

0 class - very good share or blance of black and white
9 class - poor share or balance of black and white



ABOVE: Picture number 3, a more minimal arrangement of pattern, recalling early Bauhaus works.

Question Q2 - Evaluate the variety in the graphic.

0 class - strong or pleasing variation
9 class - extremely monotonous

Question Q3 - Evaluate the work as seen by the taste of an "average viewer" (chances for sale of the work).

0 class - highest value for sale
9 class - lowest value for possible sale

Question Q4 - Rate the "casualness" of the graphic.

0 class - very casual, or free
9 class - constructive or least free

Question Q5 - Evaluate by the term, "piece of art".

0 class - a fine piece or work of art
9 class - not a piece or work of art

Question Q6 - Rate the amount of "information" in the pictures.

0 class - highest content of information
9 class - smallest information content

Question 7 - Rate the "general impression" (liking) for the graphics (all 10 classes).

For testing purposes, the following question T1 was added:

Question T1 - Study only the pictures 4, 6, 7, and 9. Evaluate your "general impression" (liking for the works).

PROCESS OF EVALUATION

For the analysis the methods "Paired Comparisons", /2/ and "Spearman's Correlation of Classes" /3/ were employed, using the program system SPSS with the Model SSA1. /4/ These methods are briefly described and shown by a model example:

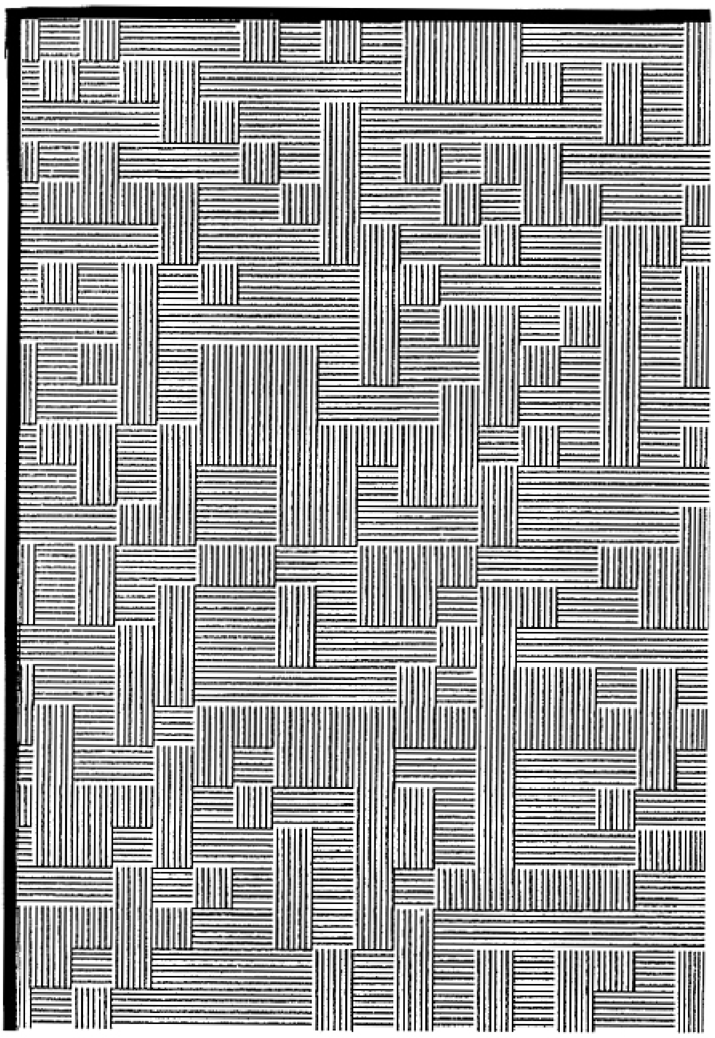
Three persons, A, B, and C have answered question Q2 (variety) as follows:

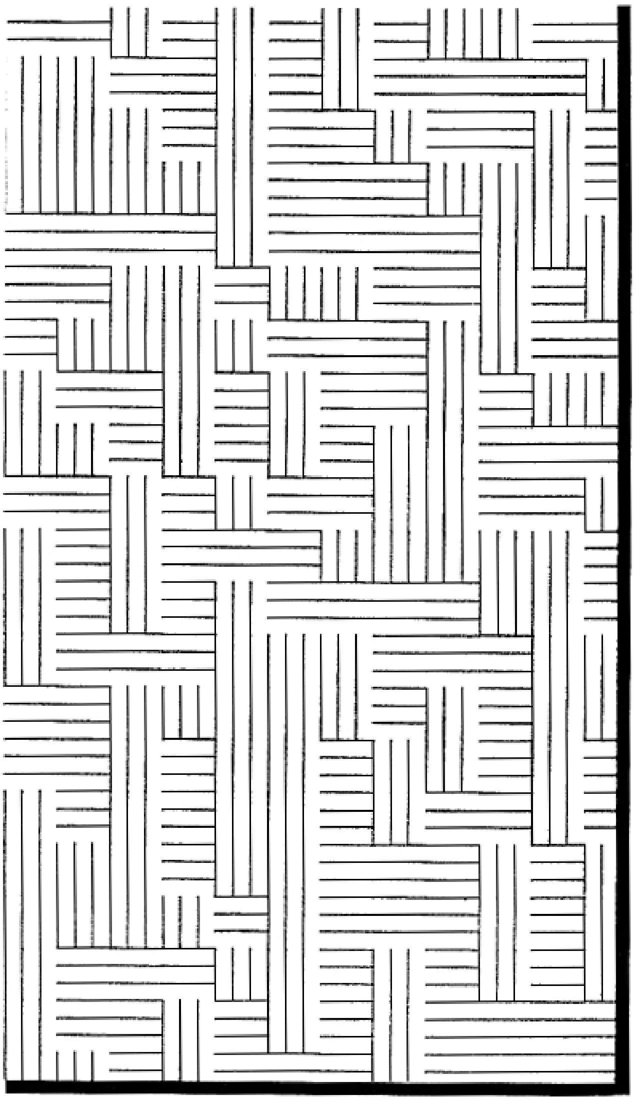
	0	1	2	3	4	5	6	7	8	9 ←(CLASSES)
A	8	1	10 ↖					↗ 9	4	5
B	1	8	1 ←		pictures			→ 6	10	5
C	1	8	2 ↙					↘ 9	4	5

The classes 3, 4, 5, and 6 which do not appear in the test can be randomized according to various methods, in order to complete the classes. An example of this method is given below:

	0	1	2	3	4	5	6	7	8	9 ←(CLASSES)
A	8	1	10	6	2	3	7	9	4	5
B	1	8	2	7	3	4	9	6	10	5
C	1	8	1	6	3	7	10	9	4	5

BELOW: Picture number 4, with precise, even spacing of lines, but with fine variations of the modules within the graphic.





ABOVE: Picture number 5, evenly spaced, sparce elements of pattern, differing markedly from number 6, at right.

Interpretation - Person A rates picture 8 as the most varying one. Persons B and C prefer picture 1. All the three persons share the opinion that picture 5 is the work with the least variety, or the most monotonous one.

However, they are not agreed on the frequency of variety in picture 10: Person A rates the graphic as class 2 (third place); person B finds it to be class 8 (this is penultimate, or next to the last place); person C finds it to be somewhere between class 3 and class 6.

Next the data is transformed into another style of representation. In this way, the method "Paired Comparisons" can be applied immediately, and the correlation values according to Spearman can be determined more easily. The transformation of the data is obvious ("exchange" of classes and pictures). An example is given below:

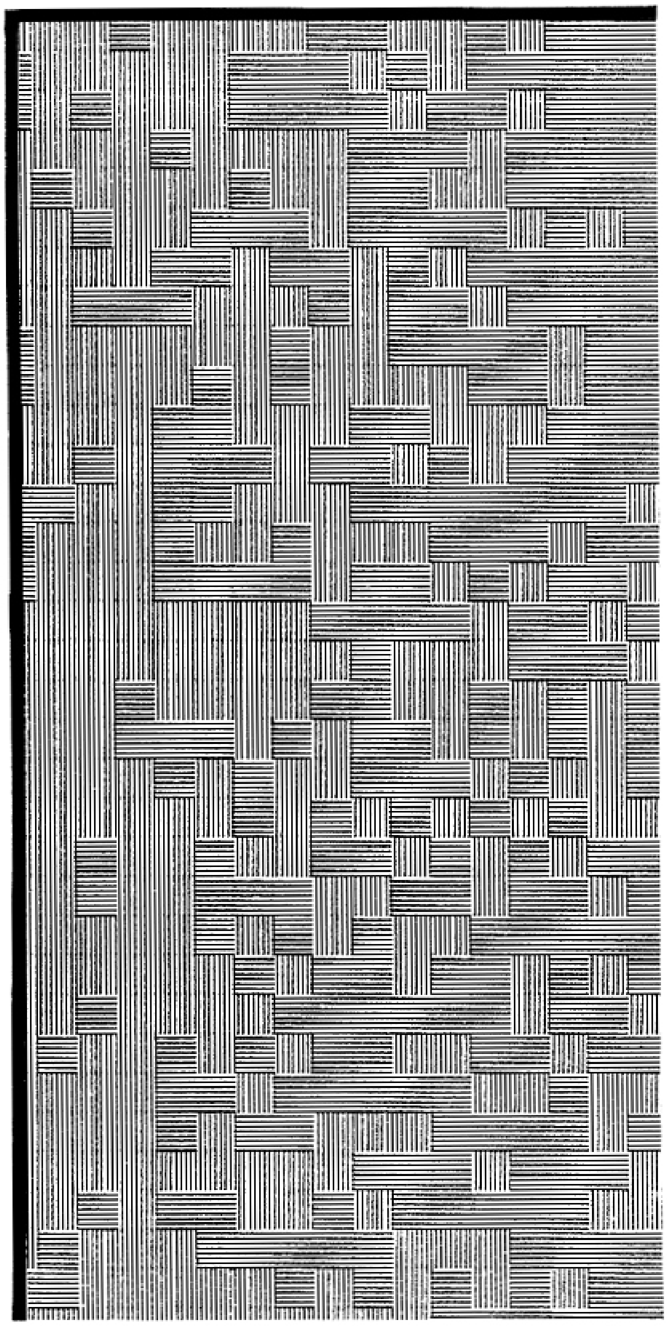
	1	2	3	4	5	6	7	8	9	10←(PICTURES)	
A	1	4	5	8	9	3	6	0	7	2↖	
B	0	2	3	5	9	7	3	1	6	8←	CLASSES
C	0	2	4	8	9	3	5	1	7	6↙	

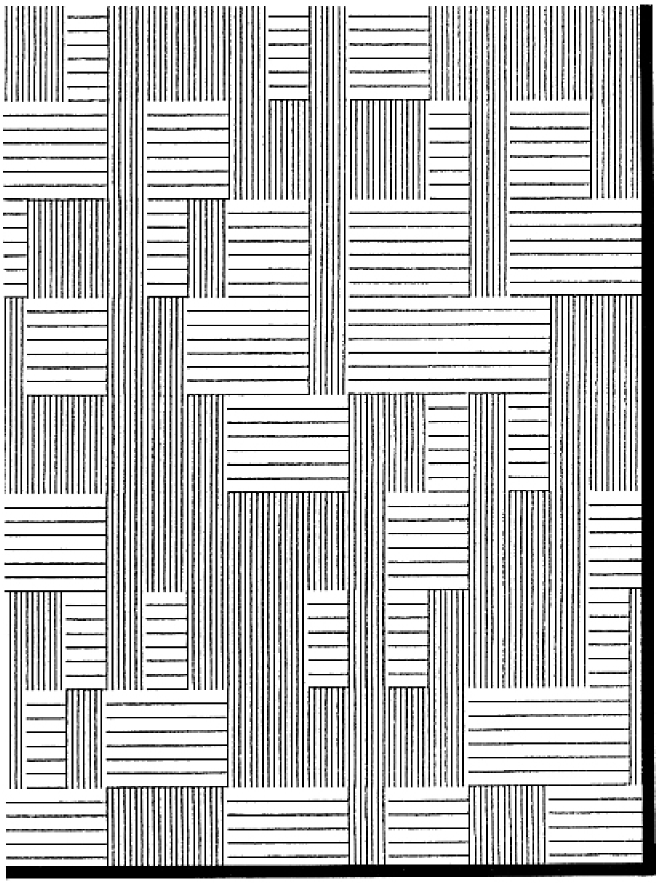
In the above example, picture 4 has been rated 8 by person A; 5 by person B; and 8 by person C.

The application of the method Paired Comparisons involves certain basic conditions, which cannot be attended to in detail here. Our test data do meet these conditions. It is possible to obtain a real metric scale by this method, totaling up the single rates for each picture. The admissibility of this summing can be taken from the article, given as Reference 2.

	1	2	3	4	5	6	7	8	9	10←(PICTURES)
A	1	4	5	8	9	3	6	0	7	2
B	0	2	4	5	9	7	3	1	6	8
C	0	2	4	8	9	3	5	1	7	6
Σ	1	8	13	21	27	13	14	2	20	15←SUM OF CLASSES

BELOW: Picture number six, closely related to 4.





ABOVE: Picture number 7, another variation of form.

In order to see the reliability of the scale obtained by the method of "Paired Comparisons", (i.e., in order to be able to measure the coincidence of the opinions of the test persons), the correlations of the persons had to be determined after the method of Spearman.

Correlations are a measure for the coincidence of opinions, facts, etc. The values (intensity) of correlations are always between -1 and + 1.

Two opinions are:	Correlation "r":
- exactly identical..................	+ 1
- almost identical......higher, about	+ 0,8
- very similar.......... " "	+ 0,5
- quite similar......... " "	+ 0,3
- not obviously related............. to each other	0
- exactly opposite..................	- 1

Correlations can be calculated by successions of classes. Here is an example:

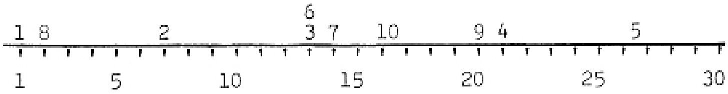
i =	1	2	3	4	5	6	7	8	9	10
A	1	4	5	8	9	3	6	0	7	2
B	0	2	4	5	9	7	3	1	6	8
C	0	2	4	8	9	3	5	1	7	6

The formula by Spearman for two marks, in this case persons, is the following:

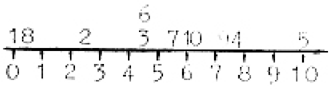
$$r = 1 - \frac{6 * \sum Di^2}{n\ (n^2-1)}$$

Di = differences between two classes
n = number of rates
$\sum$ = sum

The scale obtained for the pictures for Question Q2 (variety) with persons A, B, and C is given below:



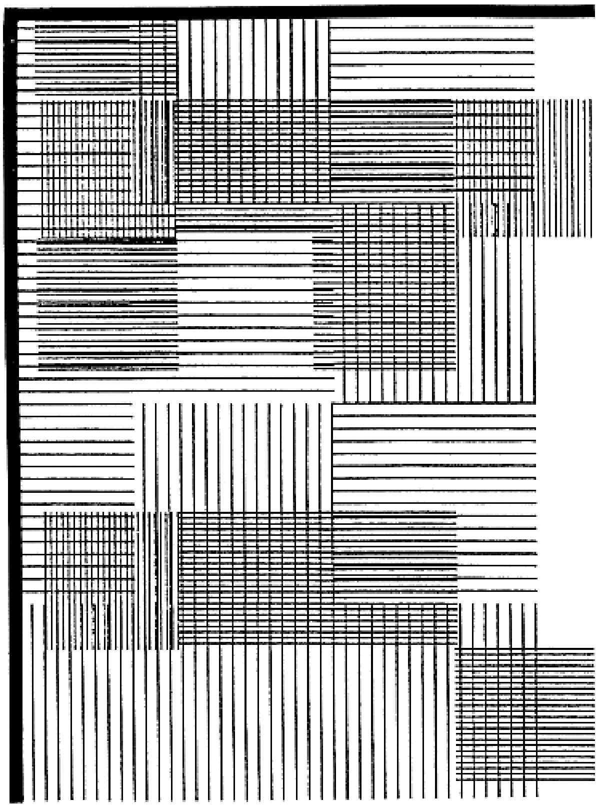
This shows the "average" valuation of the 10 computer graphics in real metric distances. To enable this scale to be compared easily with other ones, the scales have to be transferred into a "standard scale", between 0 and 10 (so-called standardization).

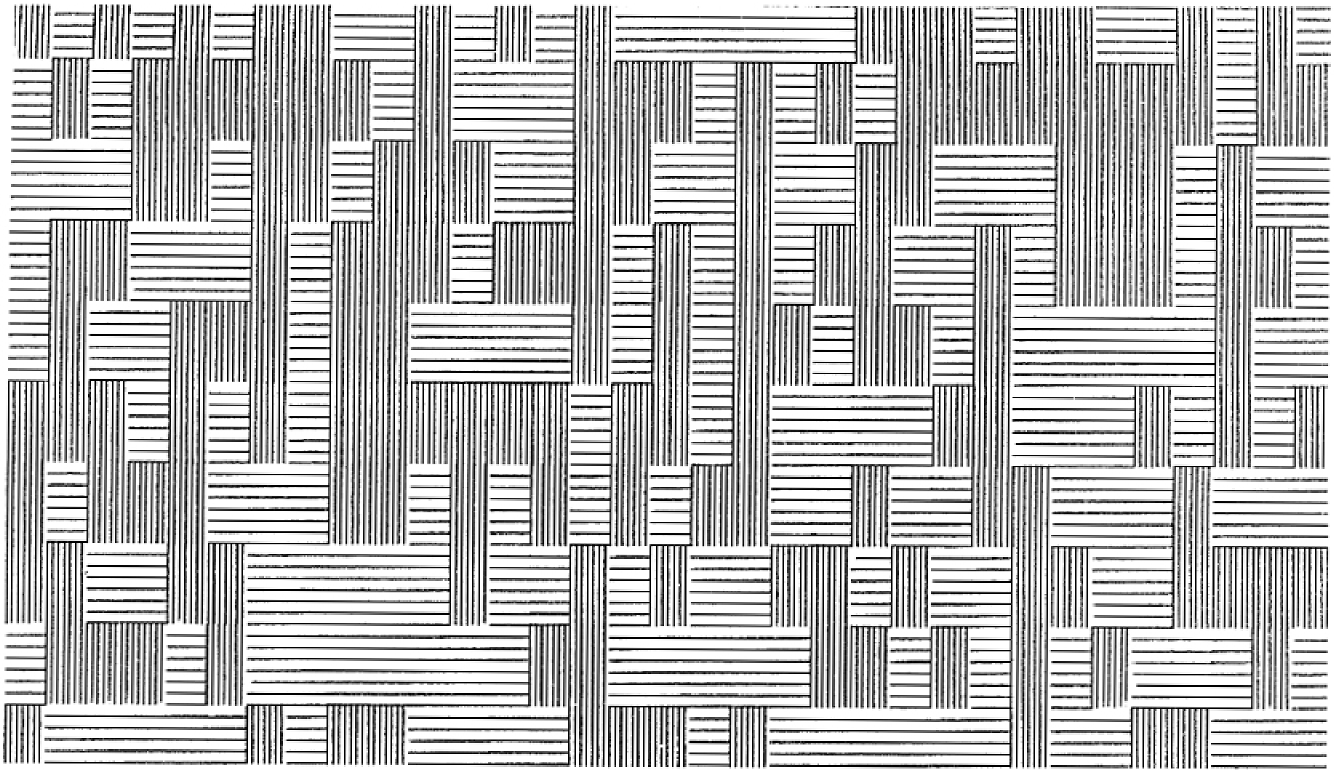


In summary, from this test, the following results were obtained:

- pictures 1 and 8 are the most varying ones;
- picture 2 is also considered to be rather varying;
- pictures 3, 6, 7, and 10 range in the middle of the classes (almost equally evaluated);
- pictures 9 and 4 are less varying; that is, they are more monotonous;
- picture 5 is the least varying, or the most monotonous of all the pictures.

BELOW: Picture number 8, intersecting patterns.





ABOVE: Picture number nine, more closely related to number 7. Note: All the pictures have been judiciously cropped to show details of the works. This in no way interferes with the compositional elements or values of each work.

Comparison between person A and B:

i =	1	2	3	4	5	6	7	8	9	10	
A	1	4	5	8	9	3	6	0	7	2	
B	0	2	4	5	9	7	3	1	6	8	
Di	1	2	1	3	0	-4	3	-1	1	-6	
Di^2	1	4	1	9	0	16	9	1	1	36	=78

$$r_{AB} = 1 - \frac{6\ \ 78}{10\ (100-1)} = 1 - \frac{468}{990} = +0{,}527$$

The different opinions of the persons A and B correlate: r_{AB}=0,53. The correlation between person A and C, as well as between B and C can be calculated by analogy. The results are:

r_{AC} = +0,86 and r_{BC} = +0,79.

The range of all the correlations lies between +0,53 and +0,86. This is represented by a so-called correlation matrix:

r	A	B	C
A	/	+0,53	+0,86
B	+0,53	/	+0,79
C	+0,86	+0,79	/

Additionally, the measures "range 1", "Median m_e", "most frequent value m_h" and the expression "valuation w" have been applied to describe the correlation of the test persons.

A few lines are given to exemplify the determination of these measures. Supposing the following correlation values have been calculated:

+0,23; +0,69; +0,73; -0,12; +0,61.

The values are represented in round figures, sorted increasingly:

-0,1; +0,2; +0,6; +0,7; +0.7

This means that range 1 reaches from -0,1 to +0.7 and Median m_e (50% limit) is:++0.7.

The author, to facilitate the survey, summarized these values subjectively under the term "valuation w" with:

+++ = very high correlation (reliable scale)
++ = high correlation
+ = poor correlation (unreliable scale)

Our example would get "++" or "+".

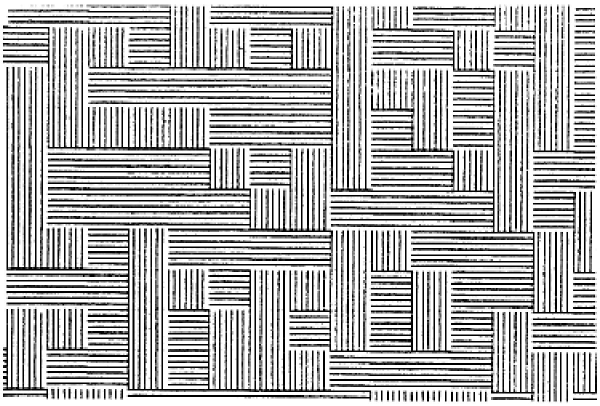
The methods "Paired Comparisons" and "Spearman's Correlation of Classes" as described above are to be employed at each question. The result is a "standard scale" and correlation values of the persons.

The standard scale of each question can be compared with the scales of the other questions and coincidences can be measured. It is also significant to correlate the class data of each person against each other, and to determine the resulting correlation values (coincidences).

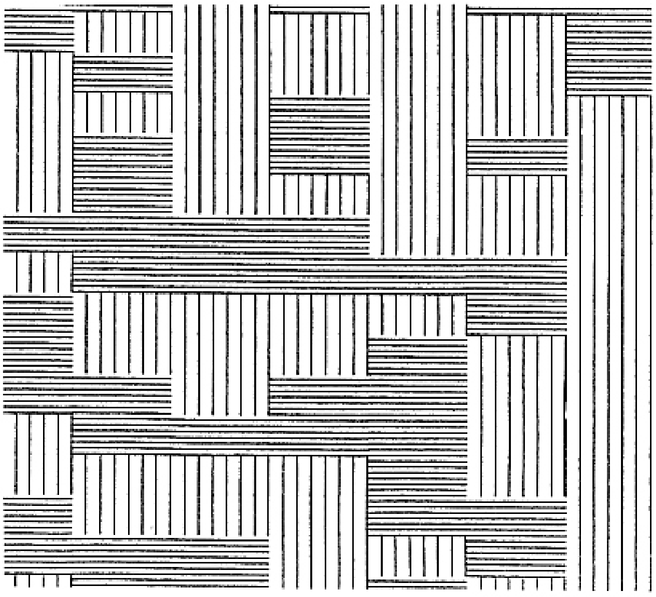
This coincidence test results in a correlation matrix of the questions, in which the correlation (degree of similarity) among the single questions is to be seen directly.

This particular analysis was made under the program system SPSS with the Model SSA1 at the

Leibniz Computing Center of the University of Munich. The Center owns a computer system CYBER 175 by Control Data. The evaluations according to the methods "Paired Comparisons" and "Spearman's Correlation of Classes" were programmed by the author.



ABOVE: Detail of Picture #4.



ABOVE: Detail of Picture #7.

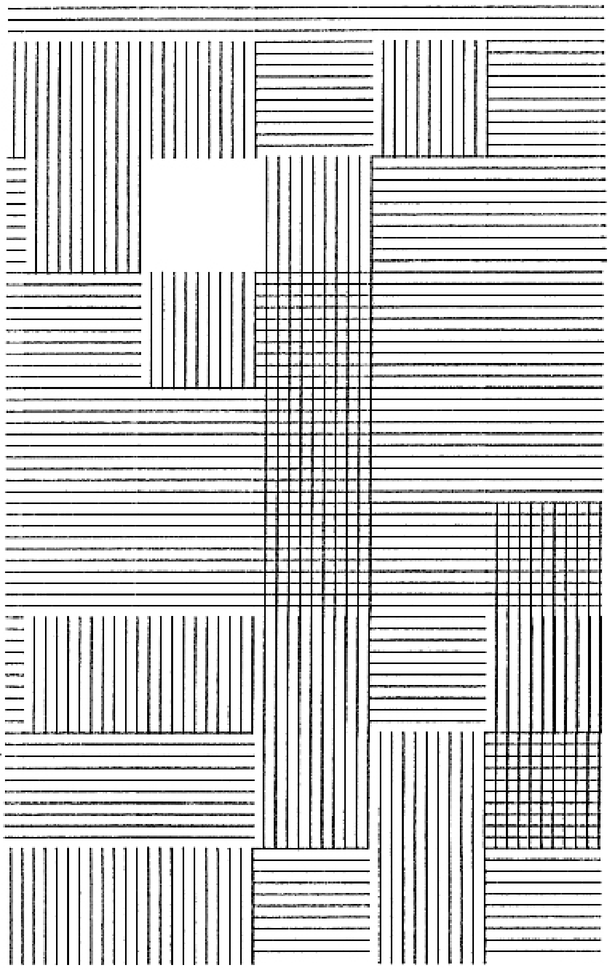
RESULTS OBTAINED WITH THE ART TEACHERS

Questions	Paired Comparisons "Standard Scale"	Spearman's Correlation of the Test Persons range 1		m_e	m_h	w
Q1	7 1 2 9 8 10 4 6 5 3	-0,5	+0,9	+0,4	+0,7	+
Q2	1 8 7 3 2 6 9 4 5 10	-0,5	+0,9	+0,2	+0,1	++
Q3	1 6 4 8 2 7 9 10 3 5	-0,1	+0,8	+0,3	+0,1	+++
Q4	3 5 9 4 10 7 6 8 1 2	+0,5	+0,9	+0,7	+0,7	+++
Q5	1 3 8 6 4 2 5 10 9 7	-0,4	+0,8	+0,3	+0,4	++
Q6	1 3 8 6 7 2 4 9 5 10	+0,0	+0,8	+0,4	+0,5	+++
Q7	1 3 6 2 8 4 7 5 9 10 0 10	-0,2	+0,9	+0,3	+0,5	++
T1		-0,4	+1,0	+0,4	+0,8	++

CORRELATION MATRIX OF THE QUESTIONS:

		Q1	Q2	Q3	Q4	Q5	Q6	Q7
BLACK/WHITE	Q1	/						
VARIETY	Q2	+0,6	/					
AVERAGE VIEWER	Q3	+0,4•	+0,7•	/				
CASUALNESS	Q4	-0,6•	-0,5	-0,7	/			
PIECE OF ART	Q5	-0,1•	+0,7•	+0,5•	-0,1•	/		
INFORMATION	Q6	+0,3•	+0,9	+0,6	-0,2	+0,8	/	
LIKING	Q7	+0,2•	+0,8	+0,7	-0,3	+0,9	+0,9	/

NOTE: The values marked with (•) are still very unreliable.



ABOVE: Picture number 10, related to number 8.

INTERPRETATION AND PRACTICAL USE OF THE TEST

In consequence of the detailed representation of the methods and expressions employed, the reader is able to interpret the results easily by himself. The observation of the following points is important:

1. The uniformity of the test material (one class of computer graphics) and the homogeneity of the test group (art teachers from the course, Computer Graphics);
2. The relatively small number of 18 test persons;
3. The "middle" classes of the questions Q1 to Q6 had to be filled in according to various random methods.

The two latter points led to the fact that some questions have correlation values marked with stars (*), whose factors of insecurity are rather high. However, the other correlation values seem to be reliable, and an interpretation of the present results with this group of persons (art teachers interested in computer graphics) appears to be significant.

Even a superficial look at the single scales shows a special position of picture (or Figure) 1. Like the other pictures, it has been produced by the routine SNEKAO of the graphic system, SNE COMP ART 76 -- but it is the only one that has been "distorted". More formal, different reactions are to be found in the parameter data to SNEKAO for the pictures 10 and 5, which also take in a special position on the scale. Also, the single evaluations of picture 3, which the reader can see for himself from the scales, are very interesting. For this picture the parameter shows one very extreme value. Almost the same is true of picture 7.

This and other detailed results supports the author's opinion that optimal computer graphics designing on the basis of the formal (that is, automatable) criteria must be feasible.

Looking at the correlation values of the questions, the extremely high correlation values among the questions Q5 and Q6 to Q7 are worth studying. This gives rise to the assumption, that for an artist, the criteria: art (piece or work of art), information (innovation), and liking (general impression) are almost the same. Also questions Q6 and Q7 are very highly correlated with question Q2. This means that a similar situation exists between the expression, variety -- at least towards the criterion information (innovation).

It is very interesting to see the separation from the criterion Q3, taste of an average viewer (or chances for selling). The correlation of Q3 with Q7 is smaller than of Q5 and Q6 with Q7. This means that the impression (Q7) of an artist is, according to the opinions given in the test, very different from the taste of the "average viewer" (Q3). It is significant to compare this with the rating of an average viewer (Q7 as well as Q3).

The component Q1 (balance or share of black and white) refers to certain effects of the surface. For example, in etchings, there is a good proportion of black and white, and in drawings, a lesser proportion of black and white. No direct influence of this criterion on the liking of computer graphics could be observed.

The criterion Q4 (casuality) seems to be completely different. All the correlation values are negative. If we look at the formation of Question Q4:

Question Q4 - Classify or evaluate the casuality of the graphic.

0 class - very casual
9 class - constructive, not casual

We see that the succession of the classes is "casuality - constructiveness". If the succession was determined "vice versa", like this: "constructiveness - casuality", all the correlation values of Q4 would have the same value -- with the only difference that they would now be positive.

In continuing this idea, let us do this, and call Q4 now Q4C (constructiveness). The correlation value of Q4C with Q3 is now +0.7, the one of Q4C with Q7, +0.3. This is a very interesting statement. According to the opinion of the test persons (art teachers), the criterion of Q4C (constructiveness) correlates considerably higher with Q3, or taste of the average viewer than Q7, general impression of an artist. Simply speaking, the average viewer tends much more towards constructiveness (or more structured placement) than does the artist. The author confirms this statement based on his experience with computer graphic courses. The components of the casual (or of the random generator) in computer graphics should not be given that important function (or place of importance) as it still has for many people.

INSTRUCTIONS FOR APPLICATION OF THE TEST

The graphics are to be set up in the order of their numbers in front of the participants. Then the questions are to be distributed in the following order: Q7, Q4, Q3, Q2, Q1, Q6, and T1 as the last one. Each question is handed out separately, using an extra sheet of paper for each one. The sheets are gathered after they have been filled in by participants. This serves the purpose that each question is answered independently from the others.

Take also into account, which category of persons forms the group. Within this test, the classification of "artists" and "non-artists" appears to be successful.

Those who want to apply this test for other purposes (as in seminars or exercises) may contact the author, who is in a position to evaluate the results of the test, with the programs provided for this purpose.

SUMMARY

There is a growing need and interest in evaluating computer graphics objectively. This paper presents some ideas that may be useful in this search for the "measurable". The author will continue this research and will publish further results of this work in this and other journals.

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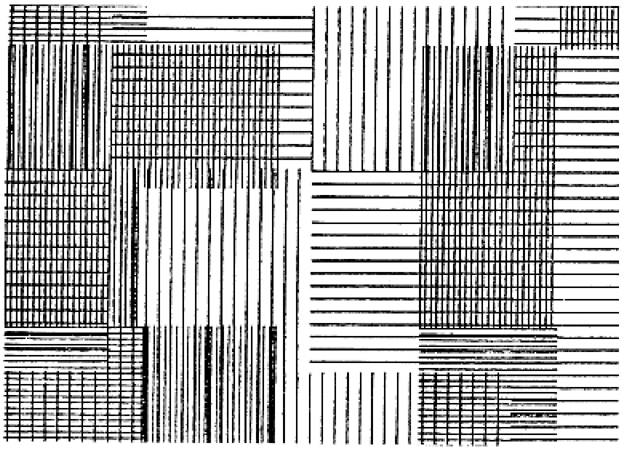
/4/ Toledano, S., "Smallest Space Analysis - A New Subprogram 'SSA1' in the SPSS Package", Hebrew University of Jerusalem, Computation Center.

BELOW: Detail of #8.



NOTE: CONFERENCE PROCEEDINGS will be available for $10 from the Department of Computer Science, University of Iowa.

The University of Iowa

The University of Iowa, Iowa City, is holding a very special conference in memory of Gerard P. Weeg, a pioneer in academic computing, and one of the founders of the conferences titled "Computers in the Undergraduate Currilulum" series. Dr. Weeg saw the computer as a revolutionary force in higher education. He was a person respected and loved.

As a special tribute to Dr. Weeg, the Computer Center will be dedicated, to be retitled GERARD P. WEEG COMPUTING CENTER. Dates are May 1-2.

The objectives of the conference are:

- To explore ways that computing affects how and what we study;
- To look at different ways of providing computing at both small and large colleges;
- To identify the probable effects of the new technology on our institutions.

The title of the May conference is COMPUTING IN COLLEGE AND UNIVERSITY: 1978 AND BEYOND.

Invitational speakers for the conference are:

JOHN HAMBLEN -- University of Missouri, Rolla
"Computers in Education: Cycles and Trends"

JOHN EULENBERG and MORTEZA RAHIMI - Michigan State University
"Equality of Educational Opportunity through Computer Technology"

ARTHUR LUEHRMANN -- University of California, Berkeley
"Pre- and Post-College Computer Education"

STEVEN HEDETNIEMI -- University of Oregon
"Future Trends in Computer Science Curricula"

SEYMOUR PAPERT -- Massachusetts Institute of Technology
"Personal Computing and its Impact on Education"

WALTER DOHERTY -- IBM, Incorporated
"Computing in the Research Environment"

TOM KURTZ -- Dartmouth College
"The Case for the Network"

SISTER MARY KENNETH KELLER -- Clarke College
"The Microprocessing Revolution and its Effect on Small Colleges"

GRACE HERTLEIN -- California State University, Chico
"The Reshaping of Men's Minds via Computing"

AL BORK -- University of California, Irvine
"Computers, Education and the Future of Educational Institutions

GLENN CULLER -- Culler-Harrison Corporation
"The Trend Toward Personalized Computing"